whole civilization. Great changes in the supply or the cost will inevitably react in the long run upon the opportunities for employment and support, and upon the very nature of our national life. While it will be a long time before rearrangements in the case of the most important of the metals, iron, will be manifest, and while they will assert themselves gradually, we are quite certain to face new conditions in copper, lead and zinc at an earlier date. In the end, however, we can perhaps justifiably forecast a future in which agriculture will figure more and more prominently and in which the moral, intellectual and spiritual life of the nation will readjust itself accordingly. Great and concentrated wealth is likely to be less in evidence, materialistic influences less pronounced, and from the vantage ground afforded by the greater comforts and opportunities of modern life as compared with that of a century or a half century past, we may in the distant future look forward to an evolution upon somewhat different lines. Broadly viewed, the national life will probably be increasingly sympathetic with art and with ideals.

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CITY SANITATION[1]

Great cities have grown and passed out of existence. The enormous increase in urban population in very recent years has produced even greater cities, which may also in time cease to be. In fact, aside from the possibility of local or cosmic calamity, this is sure to occur, unless due attention is given to the application of the principles of chemistry in our daily, personal and communal life. London, Paris, Bombay, Rome and New Orleans have had their scourges in the past to testify to the fearful penalty of ignorance and neglect.

Indications point to an urban growth and development, the conception of which taxes the imagination. When we see New York as it was two hundred years ago, and then one hundred years ago, and as it is now, we may well wonder what it may be fifty years from now. The annual increase in population is about 300,000. It has been calculated that in 1920 New York may have 7,000,000 of people.

It has been predicted by a close and conservative student of sociology that two generations may see the eastern part of our country mainly composed of contiguous cities. In 1790, 3.3 per cent. of the population of the United States was urban. It was 33.1 per cent. in 1900. The problems of the state and county become closely interwoven with those of the city. The city will no longer be merely an accumulation of human beings in a particular locality, with its local problems and influencing the state mainly in a financial way, but the city will have become the state.

The individual needs fresh air, pure water, good food, safe shelter, and should have a clean body and something beautiful to look at. When he associates himself into a city his needs are not lessened, but emphasized. The growth of a city causes it to assume, willingly or no, corresponding obligations. The inhabitants must breathe, they must be fed and watered, its wastes must be got rid of, facilities for the safe coming and going of its people at all times must be provided, as well as protection from fire or other adventitious circumstances which concern the welfare of the citizens. The needs thus simply stated are to be met by obligations which become more and more complex with the increase in population. In fact, most of the city's problems are of comparatively recent date.

[1] An address at the tenth Conference of the Health Officers of the State of New York, Buffalo, N. Y., November 17, 1910.

With your permission I shall address my remarks to certain specific matters which have come under my observation in Greater New York, and to which I have given special study. No doubt these matters have already been considered in some of your conferences, but the public expression of the independent point of view of one unhampered by official ties may serve one good purpose, namely, of provoking discussion, which can be made profitable.

The consideration of the air of cities involves not only the principles of ventilation, which will not be considered here, but the construction of the streets, means of transportation, the disposition of wastes, and the handling of the more unusual contaminants, which vary with conditions.

There are more than 2,000,000 miles of public roads in the United States outside of municipalities. These roads in many cases are essentially the same as we find in the outskirts of our larger cities, and are the roads of the smaller towns. The town roads are traveled very much more, so the actual facts at hand for the average road are applicable to the town roads, for which no satisfactory data are available. Cushman has calculated that 500,000 tons of dust are raised on the public roads per day, or, taking 100 dry days in the year, 50,000,000 tons of material are taken from places where it is needed and placed where it is undesirable by the movement of ordinary vehicles. A discussion of economic principles of road conservation is not germane to our subject. Suffice it to say that the modern motor-driven vehicle is not a dust maker, but a dust raiser.

The dust problem did not begin with the introduction of the automobile, although it has undoubtedly been accentuated by this mode of travel. There are sections of our country at the present time where the roads have been rendered practically dustless, and neither horse-drawn vehicles nor automobiles can now deposit the dirt of the highways in the gardens and houses of abutting property owners. This condition of affairs did not exist before the introduction of the automobile, but has been arrived at in answer to the demand which has followed its use. In short, there are many suburban communities in which life to-day is far more agreeable, pleasurable and possible than it was before automobiles came into use.

Why may we not have this in every city?

Aside from the personal discomfort from flying particles of solid material, whatever be its nature, these particles are the bacterial aeroplanes. Sedgwick has shown that 10 liters of air taken five feet above a macadamized street in a dust storm may contain as many as 200,000 microorganisms.

There is a natural fouling of the street surface and an unnatural fouling. The natural comes from excrement from animals,[2] detritus from wear of pavements, soot and dust from the air, leaves from the shade trees, and the grindings from tires and shoes. The unnatural, or, rather, avoidable causes are: refuse thrown or swept upon the streets from buildings, refuse thrown by careless users and refuse spilled from vehicles carrying material through the streets. The latter causes are supposed to be prevented by the operation of ordinances which are honored in the breach, and these causes result in the greater cost of cleaning,[3] as the sweeper has considerable work in collecting litter before attacking the dirt, and the material is bulky.[4]

Commissioner Edwards, of New York City, says in *Municipal Chemistry* that

[2] One thousand horses will, in every working day of eight hours, deposit about 500 gallons of urine and 10 tons of dung upon the pavements. "On the Utilization of Stable Waste," see Birchmore, *Journal of the Society of Chemical Industry*, 1900, Vol. 19, p. 118.

[3] For cleaning all the boroughs in Greater New York of garbage, ashes, refuse and street sweepings, the Board of Estimate and Apportionment allowed an appropriation of $7,418,299.20 for 1909, and this amount was divided among the boroughs, Manhattan receiving $4,230,441.70; The Bronx, $560,371.30; Brooklyn, $2,492,481.20, and for general administration, $135,005.

[4] Very, "Municipal Chemistry," McGraw-Hill Pub. Co., 1910, p. 243.

There are two general methods for disposing of street dirt; namely, it may be picked up, swept up, or shoveled up, and then hauled away, or it may be washed into sewers through the agency of water, or there may be a combination of these methods.[5] As a rule, a considerable portion of the dirt is conducted away during rain storms, and some cities have especially constructed their sewers with the view of conducting off all dirt which can be reasonably emptied into them; in fact, it may be said that many municipal engineers consider that the sewerage system of a city should be constructed in such a way that it will carry off a large portion of the fine dirt from the streets.

I will go further and say that the streets should either be made dustless or wet down with dilute chlorine water, that is, a solution of bleaching powder, or other disinfecting fluid. Both methods have been used with success and are within reasonable cost.

The topography of a district in which urban population has massed itself will, in a measure, regulate the mode of growth. Although improved methods of rapid transportation have overcome the necessity of concentration, yet business and other causes continue to make for centralization, with consequent elevation in the value of land, whose acreage is increased only by vertical expansion. The modern subway comes as a result. The air from the streets is sucked into these human mole holes. It is to be hoped that the Public Service Commission will not allow the construction of any more subways, or that subways be built in other cities, except that the tracks be separated by partitions, or that the tracks of trains going in opposite directions will be kept in different compartments. These have now been included in the specifications for the proposed subways in Greater New York. For, although much street air enters the tunnels in New York at present, a large portion of the air is simply churned by the passing trains and not quickly and properly replaced. The ventilation in the London Tubes and in the Pennsylvania-Long Island Tunnels is excellent.

There are many incidental impurities in city air that are local and more or less evanescent. I have shown that in the city of New York about 1,300 tons of sulphur dioxide are poured into the air daily in the combustion of coal. This is a sad annual economic waste of a most important chemical, some millions of dollars in value, which we do not know how to avoid or save at present.

The smoke problem has confronted every city where coal is used as the main fuel. Civilized nations are only beginning to awaken their "conscience of fuel." Our methods of utilizing coal give us a return of only five per cent. of its energy when burned, and only one per cent. when we convert that energy into electric light in the city.

Good firing is admittedly an important factor in smoke prevention, and it has even been regarded as the main factor of the problem;[6] but many authorities favor the distribution of gas as a means of at least alleviating the smoke nuisance.[7]

There have been many complaints against some of the railroads running out of New York City, because of the nuisance caused by their use of soft coal. Some of the suburban towns have taken legal action to prevent this. The solution of the smoke problem on the railroads reduces itself to the use of hard coal or oil, as the application of mechanical stokers and smoke-consuming devices to locomotive engines has

[5] Vacuum street cleaners have so far proved to be too expensive.

[6] Caborne, *Jour. Roy. San. Inst.*, 27, p. 142.

[7] For example, Lodge, Des Voeux, A. J. Martin and A. S. E. Ackerman; in this connection, see *Jour. Roy. San. Inst.*, 27, pp. 42, 64, 80, 85.

not proved to be a success, or better still in electrification.

The theory of Rayleigh[8] for dispelling fog, and with it smoke, by electrification is interesting and is demonstrable in a beautiful way on a laboratory scale, but the expense entailed and practical difficulties involved preclude its favorable consideration. However, this method is being used with more or less success in some of the smelters in the Pacific states.

One of the worst smoke nuisances about New York during the past few years has been caused by the garbage and other reduction plants at Barren Island.[9] During this process of reduction, oil and grease are extracted from animal and vegetable matter, leaving a dry residue, which is used as a base for the manufacture of commercial fertilizers, the discarded residue being burned in the plant as fuel.

At another plant in this same point the carcasses of the larger dead animals, which are transported by a regular line of boats, are burned. When the immense number of carcasses ordered removed annually by the New York Department of Health is taken into account, it is not surprising that the smoke given off with the accompanying odors should give offense to residents for miles around. The number removed during the past year included 19,000 horses and about 380,000 dogs and cats, besides about 1,000,000 pounds of condemned meat, about 80,000 pounds of "too gamey" poultry, about 3,500,000 pounds of fish and about 5,000,000 pounds of offal.[10]

The necessity for a suitable supply of potable drinking water is now well recognized in every civilized community, and it is usually provided in the city, often at great expense, yet an appalling degree of ignorance is still encountered in the country districts that is difficult to overcome. A large percentage of urban population does, and it is most desirable that every single individual in the city should, enjoy a few days or weeks in the country in the summer. The ignorance of country habits is proverbial with the urban citizen, who takes certain matters for granted. It is, therefore, not infrequent that these outings, picnics, etc., which should make for the better health, are the direct causes of unnecessary illnesses attributable directly to the drinking water, for all the liquid refreshments on these occasions are not limited to the national German beverage.

This is largely a matter of education. Every teacher of chemistry has a splendid opportunity to drive these simple matters home, and I never fail to do it with the five or six hundred young men who sit under me every year. But every citizen does not listen to lectures on sanitation, although frequent opportunities are given by the various lecture bureaus. Popular bulletins, such as those splendid sheets which come so regularly from Dr. Evans's office in Chicago, can do much good. The press, when appealed to, will render great assistance.

The public is inclined to believe that when an ample potable water-supply has been provided, all that is necessary has been done. Sanitarians know that the contrary is the case. They may point out to the citizens that sewage disposal is quite as important. They may cite the story of Dantzic, which had good water in 1869, but the typhoid rate did not decrease materially until 1872, when sewers were added. Vienna had good sewerage and bad water up to 1874; the death rate was 340 in 100,000. That year good water was supplied and the rate dropped to 11 in 100,000. With good water and no sewage the soil becomes saturated with refuse matter, a hot bed awaiting the planting of pathogenic bacterial seed. Sedgwick, referring to cholera, figuratively states that "Pettenkoffer has given the key to the whole situation by saying that filth is like gunpowder,

[8] *Jour. Roy. San. Inst.*, 29, p. 42; and *Elec. Rev.*, 47, p. 811.

[9] Parsons, "Municipal Chemistry," McGraw-Hill Publishing Co., 1910, p. 333.

[10] Parsons, *loc. cit.*

for which cholera is the spark. A community had better remove the gunpowder than try to beat off the spark; for in spite of their efforts, however frantic, this may at any time reach the powder, and if it does, is sure to blow them to pieces." The next great problem that New York City must solve will be that of sewage disposal. It will involve an expense vastly greater than the colossal sum now being spent for the magnificent new water supply.

Half the cost of living goes to pay for food. The centralization of population requires its transportation to the centers, but it does not enforce its exposure, uncovered in the streets or shops, where it collects the dirt and attracts flies. For a century it has been known that certain kinds of food could be preserved for later consumption without injury to health. There is no objection now to the preservation of food, provided it is done in the proper, that is, harmless manner. The adulteration and sophistication of food are outgrowths of the development of the city and the improved means for world-wide transportation, coupled with the degeneracy of those who live by bartering and their desire for luxuries. The chemist has been the Cartouche and Sherlock Holmes in the abominable business. Yet ignorance and disregard for the consequences so long as gain resulted have been behind the supply of one particular food, milk, which is the main support of the weak and helpless. The government has formulated satisfactory laws against the adulteration of the coin of the realm and enforces them vigorously. We have food laws now, but they are not satisfactory, nor are they always properly enforced. In fact, they can not be fully enforced as long as they admit of constant quibbling as to the meaning of common words in our language. No doubt these objections will be removed, for it is a time of fuller awakening to the conscience of our civic value.

Clothing which has been exposed to such infectious diseases as diphtheria and smallpox, is now destroyed or duly disinfected, at least theoretically. This is not the case with clothing, either second-hand or new clothing, made in the sweatshops, where we know tuberculosis is rampant. Clothing thus serves as a means for the spread of infectious diseases. This can be stopped by requiring new clothing to be thoroughly disinfected before allowing it on the market, or, better, by applying the old Mosaic law enjoining the strictest cleanliness. Moses really anticipated our modern sanitary laws, for cleanliness is the beginning and the end. The existence of sweatshops is one very dark blot upon the page of our vaunted civilization.

The problems of city sanitation no doubt can all be solved with unlimited means and unrestricted legal power and the machinery for exercising it. Practically, however, the economics involved affect the situation. Successful manufacturing enterprises usually begin with experimental plants and furthermore keep them constantly in operation afterwards as an economic means of improving their efficiency. Some cities have appreciated this principle as shown in the Lawrence Experiment Station at Boston. But these things cost money and all know what influence "taxes" are made to play in all political campaigns. It appears not unfrequently that the excuse is offered on the part of budget committees, or similar regulating bodies, for not apportioning appropriations, "we can not afford research." No political party could leave a more lasting monument, if it went out of existence, than the establishment of the principle that a great city can not afford not to establish experimental stations. If the leaks are stopped, there will be plenty left not

only to establish bureaus of investigation, but some to save as well.

A progressive manufacturer does not hesitate long in substituting more efficient machinery. He also knows that his people are more efficient and happier in good sanitary surroundings. So, even if the leaks are stopped and the cost of running mounts up, the community is the better able to bear the burden and does it cheerfully. The average American doesn't mind paying a suitable price for a satisfactory article; in fact, of late he has become somewhat accustomed to paying a little more than he should.

The complications arising from the growth of cities call not only for "the employment of well-trained, tactful, honest, energetic and fearless health officials," but also lays a responsibility upon all forms of educational activity to bring about a "better appreciation by the people at large, of what is conducive and what a menace to public health," and individual safety.

In regard to health officials, I can not refrain from expressing an opinion bearing upon the organization of a health department. In the first place the head of the health department should be an expert sanitarian and not merely a doctor of medicine, whose training in sanitation has been incidental. He should be a specialist in sanitation with the background of a medical doctor. Furthermore, the numerous details, especially financial, should not be thrown upon the head any more than the captain of a warship should look after the details of the ship's larder. The chief needs every particle of his well-trained brain and energy to deal with the great problems of the city's health. He should be provided with a financial coadjutor—a man of absolute rectitude, and as well trained as himself, but along another line —a man who will see that the purchasing power of the city's money is equal to that of a private corporation. The terms of office of these directors, technical and financial, should be limited to the period of normal human efficiency, decent pension provisions being made for them when that period shall have ended. They would thus be unhampered by any political, religious or social associations, in the conduct of the department. I recognize that such a proposition is somewhat radical—in fact in direct opposition to the opinion of some—and sounds a bit utopian, but I am glad to say that my confidence in my fellow man is such that I am willing to give such large powers to him. Our democratic government breeds men worthy of such confidence; if it does not, then it is a failure, and we are not willing to acknowledge or to accept that verdict.

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SCIENTIFIC NOTES AND NEWS

AT the Minneapolis meeting of the American Association for the Advancement of Science, Dr. Charles E. Bessey, professor of botany and dean at the University of Nebraska, was elected president for the meeting to be held at Washington, beginning on December 27, 1911. It is planned to hold the meeting of 1912 at Cleveland. The meeting of the association and of the affiliated societies at Minneapolis was in every way successful. The registration of members of the association was 663, which represents an attendance of scientific men about twice as large. Owing to the distant place of meeting, it is necessary to wait until next week for the publication of the report of the general secretary and the addresses of the vice-presidents.

PROFESSOR ALEXANDER SMITH, University of Chicago, was elected president of the American Chemical Society at the Minneapolis meeting.

AT the meeting at Ithaca the following were elected as officers for 1911 of the American